

NEW AND INTERESTING SPECIES OF THE FAMILY BRYACEAE (*BRYOPSIDA*) FROM AUSTRALIA

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Abstract

The identity of five Australian species of *Bryum*, listed by Catcheside (1980) as *Bryum* species A–E, has been determined and their taxonomy is discussed. *B. species 'A'* is *B. sullivanii* C. Muell., *B. species 'B'* is *Rosulabryum subtomentosum* (Hampe)Spence, *B. species 'C'*, a new species, is named as *B. eremaeum* Catcheside ex Spence & Ramsay, *B. species 'D'*, also a new species, is named as *B. sabulosum* Catcheside ex Spence & Ramsay while *B. species 'E'* belongs to the widespread taxon *B. dichotomum* Hedw.

Introduction

This paper is published as a memorial to David Catcheside who first discovered the new species and kindly suggested names to us for them prior to his death in June 1994, which predated compilation.

The genus *Bryum* Hedw. (Bryaceae) was revised for Australia and its offshore territories by Ochi (1970) who listed 26 species. Subsequently, additional species have been added (Streimann & Touw (1981), Ochi & Streimann (1987), Ochi (1985), Scott & Stone (1976) and problems in our understanding of certain species have been corrected (Ochi 1972, 1973, 1982, Mohamed 1979). In his treatment of *Bryum* for South Australia, Catcheside (1980) listed five taxa for which he could not find names. These taxa were assigned the letters 'A to E'. Field studies, collection of additional specimens and examination of types and herbarium material of the genus, in preparation for the Flora of Australia, have enabled us to resolve the identities of these five taxa in the light of current taxonomic concepts. Here we provide names, descriptions, distributions and phylogenetic notes for four of the five species. The fifth species (*B. species 'E'*) was found to belong to the widespread taxon *B. dichotomum*.

Two species (*B. species 'A' & 'B'*) have been placed in previously described species although the names accepted by us have earlier been placed into synonymy by others. The other two (*B. species 'C' & 'D'*) have been identified as previously undescribed species and are therefore described here. Section names for *Bryum* follow Ochi (1992).

Bryum sullivanii C. Muell.

Catcheside (1980) described *Bryum species 'A'* as rare, growing on splashed boulders or wet soil over rock along streams, generally at high elevations. He reported it from South Australia and the Australian Capital Territory. Since then, additional collections have extended its range to southeastern Australia and Western Australia (Map 1). Herbarium studies have revealed numerous specimens identified as *B. pachytheca* Hedw. or *B. erythrocarpoides* (C. Muell.)Hampe (= *B. clavatum* (Schimp.) C. Muell.) but which are the same as *B. species 'A'*. Finally, material of *B. sullivanii* from "Erskine River, Lorne, Victoria [no date or collector given]" at H-BR, determined by Brotherus, and type material "*D. Sullivan* from Mt William, Victoria (MEL 1000400)" [see Ramsay & Seur 1994] matched *B. species 'A'*.

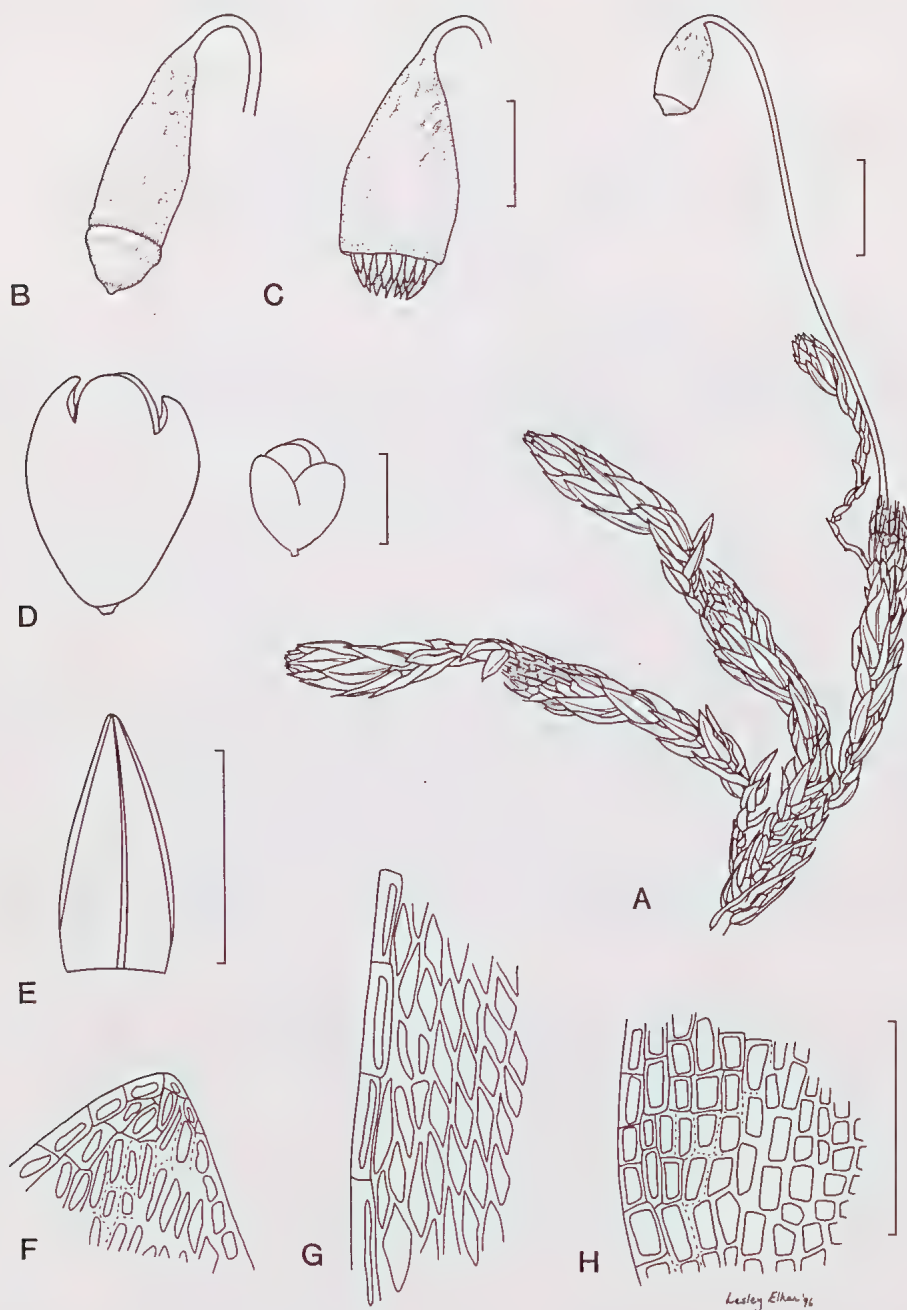


Fig. 1. *Bryum sullivanii* C. Muell. A, gametophyte bearing sporophyte [*W.A. Weymouth 2706* (AD)]; B, capsule with operculum; C, capsule showing peristome [B, C, D. *Sullivan s.n.* (MEL 1000403), Vic. 1883 (MEL)]; D, bulbils [H. Brown's River, Tas. (MEL); J.R. Spence 4288 (NSW)]; E, leaf; F, apical leaf cells; G, midleaf cells; H, basal cells [E–H, *W.A. Weymouth 2706* (AD)]. (Scale bars: A = 2 mm; E = 1 mm; D, F–H = 100 μ m).

B. sullivanii has a long and confused history. In New Zealand *B. clavatum* was originally called *B. curvicolium* Mitt. (Sainsbury 1955). Ochi (1970) placed both *B. curvicolium* and *B. sullivanii* into synonymy with *B. erythrocarpoides*. Later this last mentioned species was placed into synonymy with *B. clavatum* of South America by Ochi (1980). We have accepted Ochi's (1980) interpretation for plants in Australasia as *B. clavatum* rather than *B. erythrocarpoides*.

Comparisons between *B. clavatum* and *B. sullivanii* have revealed numerous differences. Perhaps the most striking is the sporophyte. Our understanding of *B. sullivanii* had been based on old or sterile specimens until recently when fresh fertile collections were made. The capsules of *B. clavatum* (Fig. 160, Catcheside (1980)) and *B. sullivanii* (Fig. 1) are strikingly different. That of *B. sullivanii* is short, ovate with a wrinkled thick apophysis, very similar to the capsules of species like *B. pachythea* and *B. coronatum*. The capsule of *B. clavatum* is elongate-clavate, often remarkably long and somewhat curved, with a slender tapered apophysis. There are many other differences between the species. The leaves of *B. clavatum* are acute, with the costae shortly excurrent as a stout point and the lower margins bordered by elongate thick-walled cells. The leaves of *B. sullivanii* tend to be rounded, often lacking a hairpoint, and the costae are generally percurrent. The tips of younger leaves are often strongly cucullate. The lower margins of the leaves remain unbordered. Another important distinction is in the type of specialised asexual propagules produced by the two species. *B. clavatum* occasionally produces rhizoid tubers, usually found in the tomentum on the stem, while *B. sullivanii* lacks tubers but often produces bulbils, very similar to those produced by *B. dichotomum*, in the axils of leaves.

Because of these differences, we maintain that *B. clavatum* and *B. sullivanii* are distinct species and that *B. species 'A'* of Catcheside (1980) should be referred to *B. sullivanii* (see Ochi 1970, p. 29, fig. 13; Catcheside 1980, p. 272, fig. 161 and fig. 1 in these studies). In fact *B. clavatum* and *B. sullivanii* are members of separate sections of the genus *Bryum*: *B. clavatum* is in section *Apalodictyon* while *B. sullivanii* is in section *Doliolidium*.

B. sullivanii can readily be distinguished from other members of the section *Doliolidium*. Stems range in size from 2–5 cm or more, often much larger than other species. The habitat, splashed rocks at moderately high elevations, is also different.

Selected specimens examined

AUSTRALIA: WESTERN AUSTRALIA: J.R. Spence 4249 and J.R. Spence 4255, 6.x.1990, Beedelup National Park on damp rocks along creek, Beedelup Falls (NSW); J.R. Spence 4265, 6.x.1990, Serpentine National Park, on dry exposed granite near waterfall (NSW); J.R. Spence 4271, 8.x.1990, Lesmurdie Falls National Park, on damp partly shaded soil over granite by falls (NSW); J.R. Spence 4272, 8.x.1990, Lesmurdie Falls National Park, on dry partially exposed granite rocks near creek below falls, (NSW).

SOUTH AUSTRALIA: D.E.A. Catcheside, vii.1988, Bellevue Heights, Adelaide, roof of 72 Eve Road (AD); J.R. Spence 4288 and J.R. Spence 4290, 15.x.1990, Hindmarsh Falls on Myponga-Victor Harbour Rd, wet rock in creek and on soil over rock (NSW); H. Eichler 12921, 23.ix.1956, Northern Flinders Range, Gammon Ranges, gorge of western branch of Balcanoona Creek above Loch Ness well (AD); P. Michell s.n., viii.1983 (as *B. sp. A*), Brachina Gorge, Flinders Ranges (AD); D.G. Catcheside 53.240, 26.viii.1953 (as *B. sp. A*), on wet rocks by stream, Wilpena Pound, Flinders Ranges (AD); D.E. Symon s.n. 14.ix.1964, rocky hill, Waite Institute, Adelaide (AD).

NEW SOUTH WALES: W.W. Watts 8712, i.1906, Reservoir Gully, Yarrangobilly Caves (NSW); A.J. Downing 174, 23.x.1987, Jenolan Caves, eastern side of Grand Arch, on damp limestone (NSW); W.W. Watts 8712, i.1906, Yarrangobilly Caves (NSW).

AUSTRALIAN CAPITAL TERRITORY: D.G. Catcheside 68.136, 20.viii.1968, Acton, on soil near Coombes Building, Australian National University (AD).

VICTORIA: D.G. Catcheside 77.202, 4.ix.1977, near Hamilton, on soil near the Grange Burn, Dr. McVicker's property (AD); D. Sullivan s.n., 1883, Moyston (MEL).

TASMANIA: W.A. Weymouth 2706, 4.xi.1913, Killafaddy Hill, near Launceston, on roadside (AD, NSW); W.A. Weymouth s.n., xi.1892, wet rocks, the Nut, Circular Head (HO).

Rosulabryum submentosum (Hampe)Spence

Bryum species 'B' in Catcheside (1980) was considered by him as close to *Bryum billardiarei* Schwaegr. [Spelling of *B. billardiarei* differs from previous Australian references to this taxon but follows the most recently accepted ICBN ruling that the correct spelling of the author's name be used regardless of the spelling in the original publication]. Ochi (1970) included *Bryum submentosum* (Hampe) Hampe as a synonym of *B. billardiarei*. Mohamed (1979) annotated the holotype (BM) of *Rhodobryum submentosum* Hampe [= *Bryum submentosum*] as *B. billardiarei* var. *billardiarei* but it fits better into *B. billardiarei* Schwaegr. var. *platyloma* Mohamed. Recent research, including field studies, shows that *B. submentosum* is a separate taxon. Examination of type material, collected from an unknown locality in Australia (BM, MEL) [see Ramsay & Seur 1994], was found to match Catcheside's *Bryum species 'B'*. Comparison with New Zealand material of *B. billardiarei* var. *platyloma*, described by Mohamed (1979), revealed that this and *B. submentosum* are the same taxon. Thus, *Bryum submentosum*, being the oldest validly published name, is accepted and *B. billardiarei* var. *platyloma* is placed into synonymy. *Bryum species 'B'* is identified as *B. submentosum*.

Recently, Spence (1996) described a new genus *Rosulabryum* to include most members of *Bryum* Section *Rosulata*. Australian species transferred to *Rosulabryum* include species such as *R. billardiarei* (Schwaegr.)Spence, *R. subfasciculatum* (Hampe)Spence, *R. albolimbatum* (Hampe)Spence (see Spence 1996 for a complete list of species transfers). *Bryum submentosum* is transferred to *Rosulabryum submentosum* together with *Bryum billardiarei* var. *platyloma*.

Rosulabryum submentosum is a robust member of the *R. billardiarei* complex distributed in temperate areas of Australasia (Map 2). The species is widespread in New Zealand and its offshore islands. It is common in southeastern mainland Australia and Tasmania and rare in coastal regions of Western Australia. Although very close, *R. billardiarei* and *R. submentosum* can be distinguished by several characters when used together. *Rosulabryum submentosum* has a much thicker leaf border (4–8 layers of elongate thick-walled cells vs 1–2 layers), often imparting a whitish colouration to the margin. The leaves are spatulate in *R. submentosum* and obovate in *R. billardiarei*. A common habitat of *R. submentosum* is splashed rock along streams or near waterfalls, especially at higher montane elevations. In such habitats, the plants can become remarkably elongated (to 10 cm) and pendent from vertical faces. Older stems and leaves often become blackish with age. The setae are hooked just below the capsules (see Mohamed (1979) fig. 5, fig. 2 these studies) in about 90% of *R. submentosum* collections but only in 10–20 % of *R. billardiarei* specimens.

Selected specimens examined

AUSTRALIA: WESTERN AUSTRALIA: *R. Wyatt & A. Stoneburner* 3777, 27.iv.1984, on sandy soil, track to Reserve Office, Two People's Bay Nature Reserve (PERTH); *R. Wyatt & A. Stoneburner* 4090, 20 vii.1984, Chiddercooping Hill, 43 km N of Westonia (PERTH); *R. Wyatt & A. Stoneburner* 3716, 26.iv.1984, Toolbrunup Park, Stirling Ranges National Park (PERTH); *R. Wyatt & A. Stoneburner* 4279, 16.viii.1984, Mt Chudalup, 17 km S of Northcliffe (PERTH); *D.G. Catcheside* 74.123, 17.iv.1974, Rainbow trail in Karri Forest, Pemberton (PERTH); *D.G. Catcheside* 74.291, 22.ix.1974, base of Bluff Knoll, Stirling Range (PERTH); *D.G. Catcheside* 74.179 18.ix.1974, [as *B. species B*], Cascades near Pemberton (AD).

SOUTH AUSTRALIA: *D.E.A. Catcheside*, 23.ix.1978, [as *B. species B*] south of Ashbourne (AD).

QUEENSLAND: *F.M. Bailey s.n.*, Toowoomba, (BRI); *F.M. Bailey s.n.* Brisbane (BRI).

NEW SOUTH WALES: *D. Camara s.n.*, Richmond River (NSW); *H. Streimann* 3962, [as *Bryum perlimbatum*] Crackenback River, 6 km N.W. of Jindabyne (NSW).

VICTORIA: *J.R. Spence* 4366, 22.x.1990, near Chimney Pots, Grampians, on damp soil and mud over seepy exposed rock face (NSW); *C. French s.n.*, Childers Farm (MEL); *W.W. Watts Vic* 1072, xi.1919, Erskine River, Lorne (NSW).



Fig. 2. *Rosulabryum subtomentosum* (Hampe)Spence. A, female gametophyte with capsule; B, male gametophyte; C, leaf [A–G, D.E.A. Catcheside s.n. 23.ix.1978 (AD)]; D, apical cells; E, marginal cells; F, midleaf cells; G, basal leaf cells. (Scale bars A–B = 5 mm; D–G = 100 µm; C = 1 mm).

TASMANIA: J.R. Spence 4691, 16.xii.1990, Liffey Falls (NSW).

Bryum eremaeum Catcheside ex Spence & Ramsay, *species novum*

B. pachythecae similis sed combinatione characterum sequentium differt: plante dense caespitosae, rubrovirentes, aspectu saepe incana propter aristas apicales foliorum; folia late ovata concavae, arista apicali longe excurrenti, hyalina dentataque; bulbili frequentes in axillis foliorum in surculis sterilibus, unusquisque primordiis duobus brevibus paxilliformibus per sulcum separatis; tubera ex basi partium subterraneorum caulium pullentia.

HOLOTYPE: South Australia: Mirra Mitta Bore, midway between Marree and Birdsville R.E. Grandison s.n., ix.1978 (AD) [*Bryum species* 'C' of Catcheside (1980)].

Dioicous. Plants in dense short tufts, reddish-green, 4–6 mm, often hoary looking because of the hyaline hairpoints. Leaves broadly ovate and concave, 1.5–2.0 mm; margin revolute at least to midleaf; hairpoint long, hyaline and toothed. Upper leaf cells elongate, hexagonal-rhomboidal, 3–4:1; basal cells hexagonal, becoming quadrate at margin, tending to be wider than long. Bulbils common in leaf axils of sterile shoots, one per axil, broadly ellipsoid with two short peg-like primordia separated by a groove. Stem tubers, sometimes present, budding off from the base of underground portions of stems. Calyptrae cucullate. Perichaetia on short basal shoots, perichaetial leaves larger than vegetative leaves. Setae long exserted, 1.5 cm, smooth. Capsules ovate, 2.0 mm, somewhat tapered into setae; apophyses scarcely grooved when moist, but wrinkled when dry; opercula dome shaped, apiculate; peristomes double, exostome teeth 16, lanceolate, yellowish-brown, papillose below, hyaline near tip; endostome of 16 segments, 2/3 to 3/4 length of exostome teeth, broadly perforated; cilia 2–3, appendiculate. Spores 8–15 μ m.

Proposed by Catcheside (1980) as *Bryum species* 'C', this new species *B. eremaeum* is related to *B. pachytheca*, a widespread Australasian and southeast Asian species in section *Doliolidium*. The two can be distinguished by several features. The bulbils found in leaf axils of the two species are usually present on sterile shoots. Those of *Bryum eremaeum* have small peglike primordia at the apex, with a groove between these (Catcheside 1980, fig. 156; fig. 3 these studies), while those of *B. pachytheca* are smooth and lack the primordia entirely (Catcheside (1980), fig. 155). The distinctive long, white and toothed hairpoint of *B. eremaeum* is very different from the shorter brown, golden or reddish hairpoint of *B. pachytheca*. In Australia *B. eremaeum* is found in South Australia, Victoria and New South Wales (Map 3) while *B. pachytheca* is much more widespread.

This remarkable new species is characterised by two features that are very rare in the genus. Firstly, it is one of few arid-adapted species in *Bryum* and is currently the only known species that is restricted to deserts. Secondly, the presence of stem tubers has only recently been reported for the genus *Bryum* in a single species from Kuwait (El-Saadawi & Zanaty 1990). Although they identified it as *B. bicolor*, it was sterile and may be an undescribed species.

The stem tubers appear to be derived from meristematic activity at or near the stem base (fig. 3), and are reminiscent of potatoes and other true tubers found in flowering plants. We have seen stem tubers in only one other bryaceous species in Australia, *Brachymenium coarctatum*, which occurs in open subtropical forests in Queensland. All three species for which these tubers have been recorded inhabit hot and at least seasonally dry environments. This suggests that stem tubers may be an adaptation for underground vegetative persistence at a site during unfavourable periods of heat and drought. They are much larger than rhizoid tubers, and in the case of *Brachymenium coarctatum* exceed 2 mm in length.

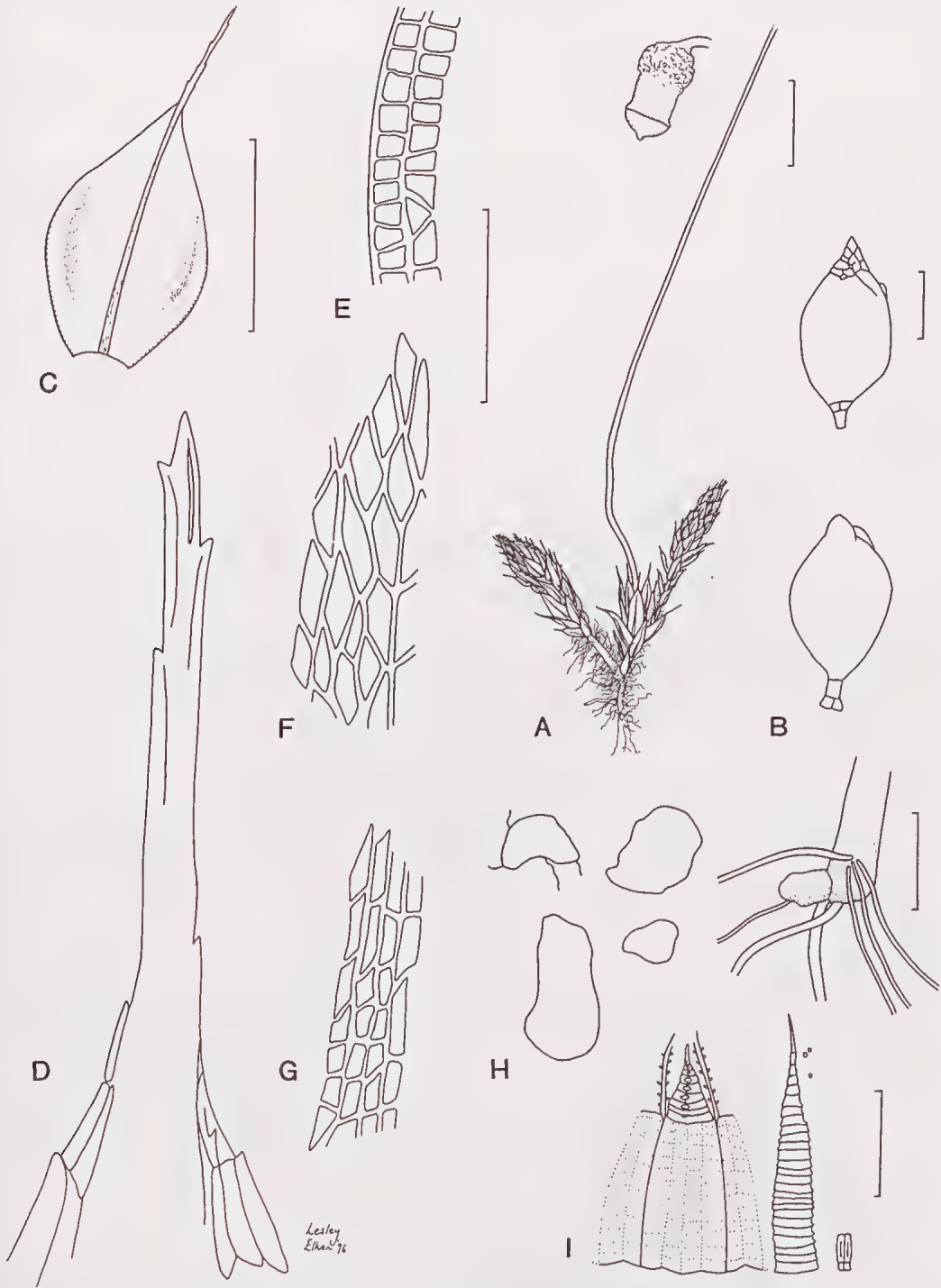


Fig. 3. *Bryum eremacum* Catcheside ex Spence & Ramsay. A, gametophyte with capsule; B, bulbils; C, leaf; D, apical cells; E, marginal cells; F, midleaf cells; G, basal cells; [A–G, holotype, *R.E. Grandison s.n.* (AD)]; H, stem base with tuber developing, range of shapes of tubers [*D.E.A. Catcheside B4, Mirra Mitta Bore* (AD)]; I, peristome [*F.M. Reader* (MEL 30772)]. (Scale bars: A, H = 2 mm; B, D–G, I = 100 μ m; C = 1 mm).

Selected specimens examined

SOUTH AUSTRALIA: *D.E.A. Catcheside B1, B4 and B6*, 26.vii.1980, Mirra Mitta Bore (AD); *D.E. Symon L1*, 23.viii.1980, Great Victoria Desert, 40 km W. of Vokes Hill Junction on Connie Sue Highway, slopes of high dune (AD).

NEW SOUTH WALES: *D.G. Catcheside 74.86*, 17.iv.1974, near Euston on soil (AD).

VICTORIA: *A.C. Beauglehole 57179*, 7.ix.1961 (as *B. pachytheca*), Kiata Lowan Sanctuary, in depression mallee area (MEL); *F.M. Reader s.n.*, 19.ix.1894 (as *B. pachytheca*) Sandy Desert (MEL); *A.C. Beauglehole s.n.*, 17.x.1960 (as *B. pachytheca*), roadside 19.3 km S of Ouyen (MEL).

Bryum sabulosum* Catcheside ex Spence & Ramsay, *species novum

B. pachythecae similis sed combinatione characterum sequentium differt: plantae minutae, saepe solitaire inter muscos alios; folia lata ovata, imbricata, aureo-brunnea, marginibus planis vel basi recurvatis; arista apicalis brevis, crassa, laevis aureo-brunnea; capsulae apophysibus crassis, laevibus vel aliquanto rugosis sed non inflatae ut in *B. pachytheca*; bulbili nulli.

HOLOTYPE: Western Australia: Porongorups, *F.Mueller s.n.* x.1867 (MEL 30812). [*Bryum species D* in Catcheside 1980].

Dioicous. Plants minute 4–5 (–10) mm, brown or golden green, often solitary among other mosses. Leaves broadly ovate, tightly imbricate, 1–1.2 mm, golden-brown, shortly acuminate; margins revolute nearly to apex; costae shortly excurrent. Upper cells hexagonal, 3:1, thick-walled; basal cells quadrate. No bulbils seen. Perichaetia on short basal shoots; perichaetial leaves somewhat larger than vegetative leaves. Calyptrae cucullate. Setae long exserted, 1–1.5 cm, red, smooth. Capsules pendulous, small, 1–1.5 mm long, ovate with thick, apophyses smooth or somewhat corrugate when dry, abruptly tapered to setae; opercula dome-shaped, short-apiculate; peristomes double, exostome teeth 16, lanceolate, yellow-brown, smooth to papillose below; endostome segments about 1/2–2/3 length of exostome, broadly perforated with high basal membrane; cilia 2, nodose. Spores 8–15 μ m.

Catcheside (1980) described a probable new small species of *Bryum* which he designated as *B. species 'D'*, known only from South Australia. He suggested that this species was related to the common widespread *B. pachytheca*, from which it differed in smaller narrower leaves and the smooth to somewhat corrugate apophyses of dry capsules (Catcheside 1980 p. 269, Fig. 4 these studies). Additional collections have been made and this species has been determined as a new species with the name *B. sabulosum*. It is a member of *Bryum* section *Doliolidium*.

Bryum sabulosum has probably been overlooked in the past because of its small size and the tendency to grow as scattered individuals in turfs of other species. Shoots are generally less than 10 mm long, often as short as 4–5 mm. The most distinctive features are the golden-brown, tightly imbricate leaves and the small ovate capsule with a thick, almost smooth apophysis that is somewhat corrugated when dry. So far, no bulbils have been found in this species. In Western Australia *B. sabulosum* occurs most commonly on dry rock outcrops or dry soil pockets on exposed rocks. It is common in the Two Peoples Bay Nature Reserve in the southwestern part of the State. In southeastern Australia it occurs on a variety of substrates including sand dunes (Fig. 4).

Selected specimens examined:

WESTERN AUSTRALIA: *J.H. Willis s.n.*, 3.x.1961, Eyre Highway 9 km N of Norseman, (MEL); *J.R. Spence 4150* (with *B. argenteum*), Petruder Rocks (NSW); *J.R. Spence 4152*, 30.ix.1990 Petruder Rocks on shaded soil near *Eucalyptus* sp. (NSW); *N.N. Donner 2869*, 2.x.1968, Duke of Orleans Bay, Hog Island, estuary of Duke Creek, 65 km E of Esperance (AD, PERTH); *G.G. Smith 285*, 10.viii.1960, Yanchep Park (MEL); *A.C. Beauglehole 14193*, 26.viii.1965, 18 km E of Piawaning, on Wongan Hills Road (MEL); *J.R. Spence 4177*, 3.x.1990, Robinsons Gully, Two Peoples Bay (NSW).

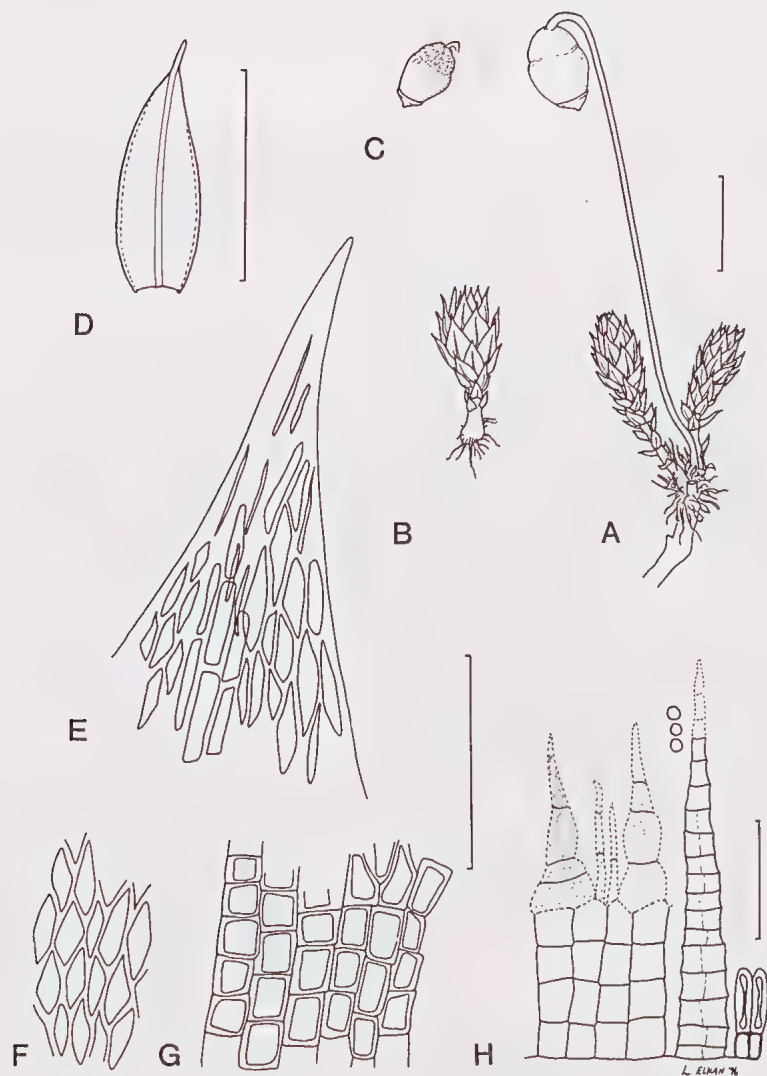


Fig. 4. *Bryum sabulosum* Catcheside ex Spence & Ramsay. A, gametophyte with young capsule; B, sterile plant; C, mature capsule; D, leaf; E, apical cells of leaf; F, midleaf cells; G, basal cells; H, peristome teeth [A–G, holotype, F. Mueller (MEL); H, from Catcheside (1980)]. (Scale bars: A–C = 2 mm; D = 1 mm; E–H = 100 µm).

SOUTH AUSTRALIA: *A.C. Beaglehole* 14969, 26.ix.1965, Eyre Highway 18 km NW of Kyancutta (MEL); *A.C. Beaglehole* 15003, 28.ix.1965, Mambray Creek, Flinders Range (MEL); *J.R. Spence* 4324, 16.x.1990, 3 km E of Athelstone (NSW).

VICTORIA: *I.G. Stone* 1694, 5.x.1969 (with *B. caespitium*), Whipstick, Bendigo (MELU); *I.G. Stone* s.n., 29.x.1978, Leigh Creek Gorge (MELU); *D.G. Catcheside* 77.148, 14.ix.1977, near Nigretta Falls, Wannon River near Hamilton (AD); *A.C. Beaglehole* 57330, 9.ix.1961, Roseberry (MEL); *J.R. Spence* 4372, 22.x.1990, Grampians National Park, on damp soil on old stump, Chimney Pot Picnic Area (NSW); *J.R. Spence* 4416, 25.x.1990, Otway National Park, on damp soil near sea cliff, Blanket Bay (NSW).

***Bryum dichotomum* Hedw.**

Bryum species 'E' of Catcheside (1980) consists of a single collection with a small ovoid capsule, smooth apophysis abruptly tapered to the seta and small red spherical rhizoid tubers. Gametophytically, the plants are very similar to *B. dichotomum* and *B. pachytheca*, although smaller. While the presence of tubers would suggest section *Apalodictyon*, members of section *Doliolidium* occasionally also produce rhizoid tubers (Smith & Whitehouse 1978, Spence 1988). We feel that the specimen in question should be placed in *B. dichotomum* based on leaf and capsule characteristics.

Key to *Bryum* Section *Doliolidium* and related species in Australia

Of the species discussed here, *Bryum sullivanii*, *B. eremaeum* and *B. sabulosum* occur in *Bryum* Section *Doliolidium* (C. Muell.) C. Muell. To assist in the identification of these we have provided a key. Couplets to sections *Apalodictyon* of *Bryum* and section *Dicranobryum* of *Brachymenium* are also included as they are closely related to this group.

- 1 Plants sometimes synoious or capsules more or less erect and with peristomes reduced *Brachymenium* section *Dicranobryum*
- 1: Plants dioicous, capsules inclined to nutant, peristomes fully developed 2
- 2 Plants with abundant rhizoid tubers, bulbils absent from leaf axils; capsules elongate-clavate with a long tapered apophysis *Bryum* section *Apalodictyon*
- 2: Plants generally lacking tubers, bulbils often present in leaf axils of sterile shoots; capsules short-ovate with a thick often corrugate or inflated apophysis (*Bryum* section *Doliolidium*) 3
- 3 Stems elongate (>1cm); leaves ovate, cucullate near tip of stem, strongly concave; costae percurrent or not reaching apex; bulbils present, with distinct leafy tips *B. sullivanii*
- 3: Stems mostly short (< 1 cm); leaf shape various, not cucullate, plane or weakly concave; costae generally short to long excurrent into distinct hairpoints; bulbils lacking or if present tips various 4
4. Leaves ovate, widest at middle 5
- 4: Leaves ovate-lanceolate, lanceolate or triangular, widest below middle 6
5. Costae long excurrent into often hyaline, toothed hairpoints; plants generally with reddish tint; capsule necks corrugate, abruptly contracted to setae; bulbils present, stem tubers sometimes present *B. eremaeum*
- 5: Costae short excurrent, golden-brown; plants lacking red tints; capsule necks almost smooth but corrugate when dry; somewhat tapered to setae; bulbils and stem tubers lacking *B. sabulosum*
- 6 Bulbils with distinct leafy primordia; capsule necks thick and corrugate or smooth and naked, not abruptly contracted to setae 7
- 6: Bulbils lacking leafy primordia; capsule necks thick, corrugate, abruptly contracted to setae 8
- 7 Capsule necks smooth, tapered to setae; leaves ovate-lanceolate, margins plane or recurved to midleaf *B. dichotomum*
- 7: Capsule necks thick, corrugate and abruptly contracted to setae; leaves lanceolate or triangular, margins strongly recurved to near apex *B. coronatum*
- 8 Hairpoints usually long and hyaline; bulbils with small peg-like primordia at tip, apices often irregularly grooved between tips; stem tubers sometimes present *B. eremaeum*
- 8: Hairpoints short, coloured, usually golden brown or red; bulbils lacking primordia, apex smooth; stem tubers absent *B. pachytheca*



Map 1. *Bryum sullivanii*



Map 2. *Rosulabryum subtomentosum*



Map 3. *Bryum eremaeum*



Map 4. *Bryum sabulosum*

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